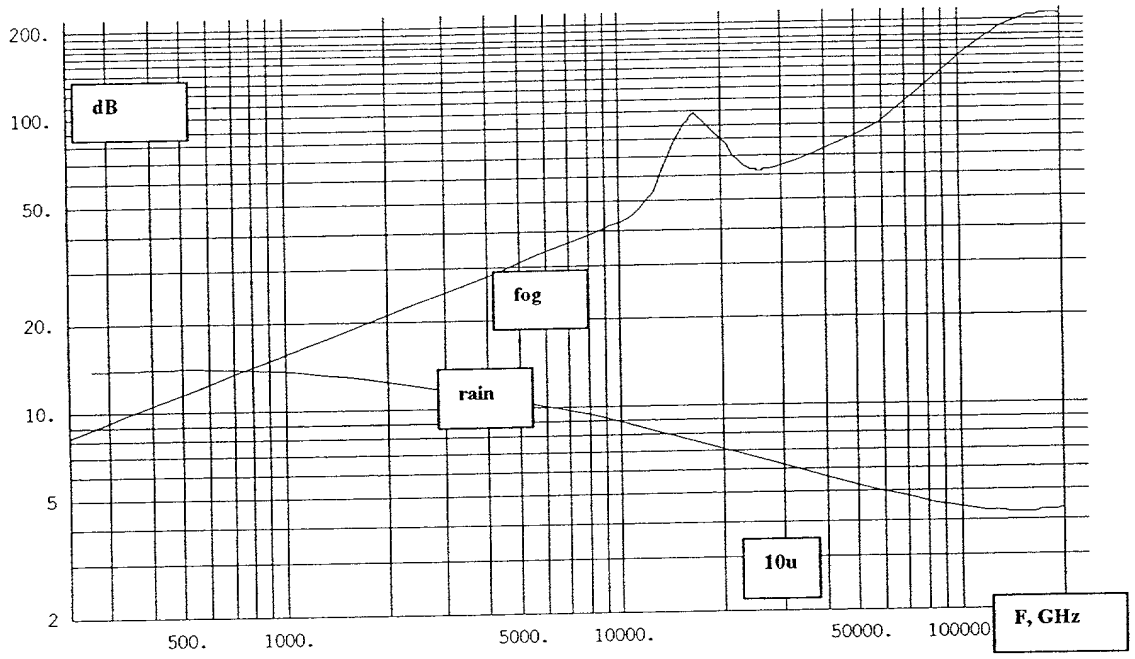
200.
100.
50.
20.
10.
5
2
dB
fog
rain
10u
500.
1000.
5000.
10000.
50000.
100000
F, GHz

Fig. 1

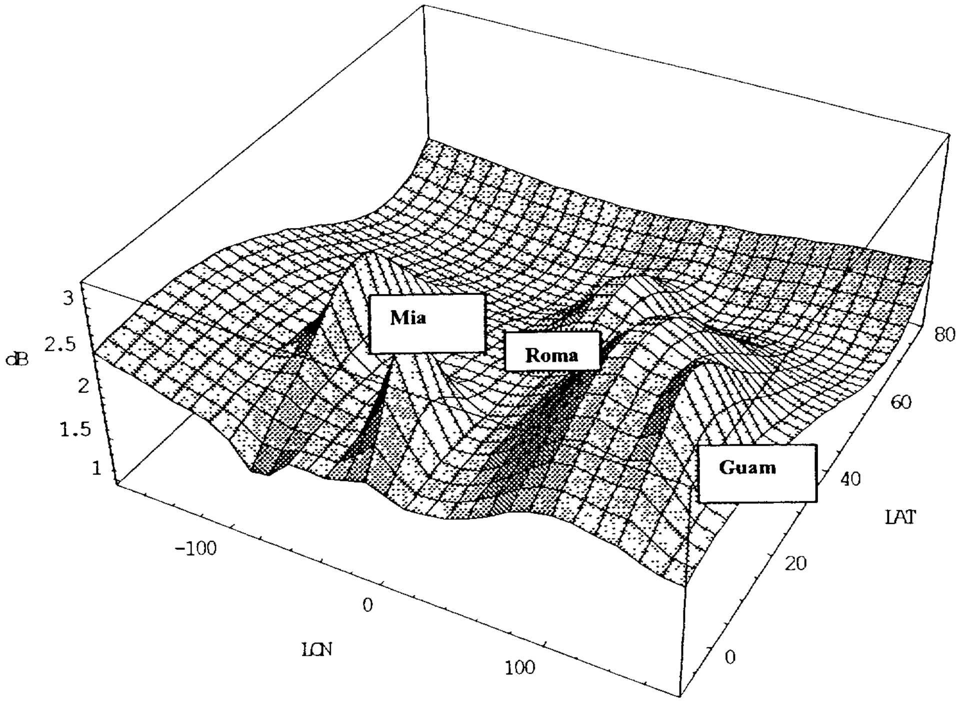
Mia
Roma
Guam
dB
3
2.5
2
1.5
1
-100
0
100
LON
80
60
40
20
0
LAT

Fig. 2

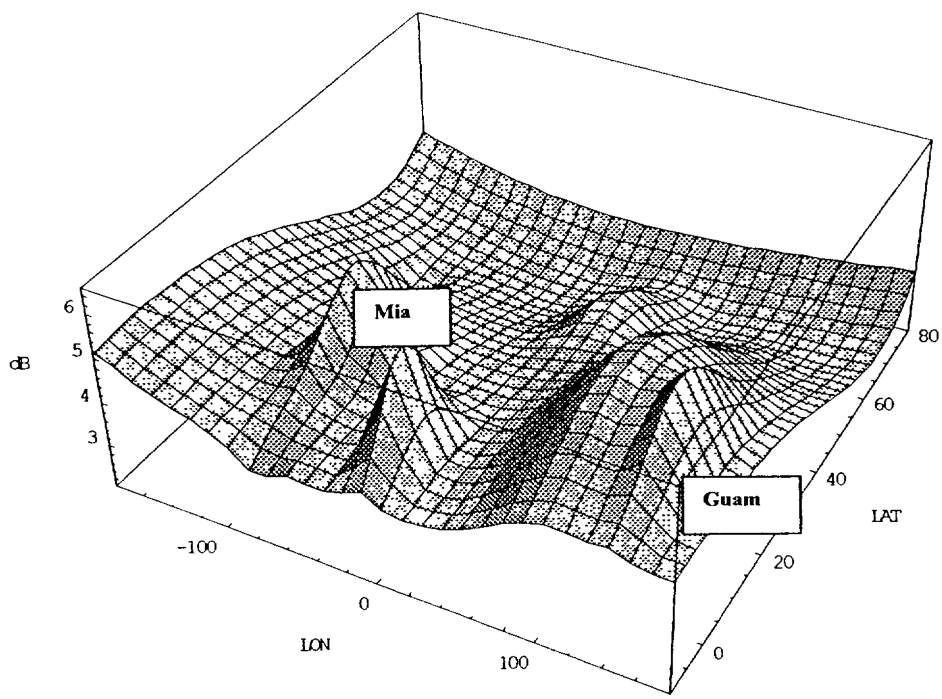
Mia
Guam
dB
6
5
4
3
-100
0
100
LON
80
60
40
20
0
LAT

Fig. 3

Short Form Global Equation for Non Rainy Zenith Attenuation (dB), For the 6-100 GHz Region; fg=Frequency, GHz

LIEBE azen=

$$0.000408122 fg^2 \left(5\ 34566 + 1.48098E^{-\frac{1}{200}(10+LAT)^2 - \frac{1}{200}(-145+LON)^2} + 2.03295E^{-\frac{1}{800}(-18+LAT)^2 - \frac{(-102+LON)^2}{1800}} + \right.$$

$$1.1968E^{-\frac{1}{200}(-52+LAT)^2 - \frac{1}{800}(28+LON)^2} - 2.78685E^{-\frac{LAT^2}{1800} - \frac{LON^2}{180000}} + 2.48024E^{-\frac{1}{72}(-2+LAT)^2 - \frac{1}{200}(7+LON)^2} +$$

$$1.41803E^{-\frac{1}{50}(20+LAT)^2 - \frac{1}{200}(60+LON)^2} - 2\ 26449E^{-\frac{1}{200}(28+LAT)^2 - \frac{1}{200}(77+LON)^2} +$$

$$1.69839E^{-\frac{1}{200}(-20+LAT)^2 - \frac{1}{128}(82+LON)^2} + 0.000898808\ LAT - 0.00187405\ LAT^2 + 8.15535x10^{-7}\ LAT^3 +$$

$$1.92203x10^{-7}\ LAT^4 - 0.000690105\ LON - 5\ 83206 \times 10^{-6}\ LAT\ LON + 3.42574 \times 10^{-7}\ LAT^2\ LON +$$

$$\left. 0.0000243378\ LON^2 + 1.15354 \times 10^{-8}\ LATLON^2 - 3.5046 \times 10^{-8}\ LON^3 - 6.44437 \times 10^{-11}\ LON^4 \right) +$$

$$0.00586939\ fg^2 \left(3.14686 + 0.665394E^{-\frac{1}{200}(-10+LAT)^2 - \frac{1}{200}(-145+LON)^2} + \right.$$

$$1.1188E^{-\frac{1}{800}(-18+LAT)^2 - \frac{(102+LON)^2}{1800}} + 0.716478E^{-\frac{1}{200}(52+LAT)^2 - \frac{1}{800}(28+LON)^2} +$$

$$1.18012E^{-\frac{LAT^2}{1800} - \frac{LON^2}{180000}} + 1.21591E^{-\frac{1}{72}(2+LAT)^2 - \frac{1}{200}(7+LON)^2} - 1.89544E^{-\frac{1}{200}(28+LAT)^2 - \frac{1}{200}(77+LON)^2} +$$

$$0.8941E^{-\frac{1}{200}(-20+LAT)^2 - \frac{1}{128}(82+LON)^2} + 0.00101461\ LAT - 0.000943554\ LAT^2 + 2.75301x10^{-7}\ LAT^3 +$$

$$1.00142 \times 10^{-7}\ LAT^4 - 0.000268921\ LON - 1.63982x10^{-6}\ LATLON + 2.33496x10^{-7}\ LAT^2\ LON +$$

$$\left. 0.0000108872\ LON^2 + 1.02349x10^{-8}\ LATLON^2 - 1.77808x10^{-8}\ LON^3 - 1.11299 \times 10^{-10}\ LON^4 - \right.$$

$$0.201139 \left(5.34566 + 1.48098E^{-\frac{1}{200}(-10+LAT)^2 - \frac{1}{200}(-145+LON)^2} + 2.03295E^{-\frac{1}{800}(-18+LAT)^2 - \frac{(-102+LON)^2}{1800}} + \right.$$

$$1.1968E^{-\frac{1}{200}(-52+LAT)^2 - \frac{1}{800}(28+LON)^2} - 2.78685E^{-\frac{LAT^2}{1800} - \frac{LON^2}{180000}} + 2.48024E^{-\frac{1}{72}(-2+LAT)^2 - \frac{1}{200}(7+LON)^2} +$$

$$1.41803E^{-\frac{1}{50}(20+LAT)^2 - \frac{1}{200}(60+LON)^2} - 2.26449E^{-\frac{1}{200}(28+LAT)^2 - \frac{1}{200}(77+LON)^2} +$$

$$1.69839E^{-\frac{1}{200}(-20+LAT)^2 - \frac{1}{128}(82+LON)^2} + 0.000898808\ LAT - 0.00187405\ LAT^2 + 8.15535x10^{-7}\ LAT^3 +$$

$$1.92203x10^{-7}\ LAT^4 - 0.000690105\ LON - 5.83206 \times 10^{-6}\ LAT\ LON + 3.42574 \times 10^{-7}\ LAT^2\ LON +$$

$$\left. \left. 0.0000243378\ LON^2 + 1.15354 \times 10^{-8}\ LATLON^2 - 3.5046 \times 10^{-8}\ LON^3 - 6.44437 \times 10^{-11}\ LON^4 \right) \right)$$

$$\left(0.665418 - 132.118 \left(-0.740741 + 0.0333667\ fg\right)^2 \right.$$

$$\left(0.999375 - 11.4943 \sqrt{(-0.740741 + 0.0333667\ fg)^2}\ \text{ArcTan}\left[\frac{0\ 0869456}{\sqrt{(-0\ 740741 + 0\ 0333667\ fg)^2}}\right]\right) -$$

$$132.118 \left(0.740741 + 0.0333667\ fg\right)^2$$

$$\left. \left(0.999375 - 11.4943 \sqrt{(0.740741 + 0.0333667\ fg)^2}\ \text{ArcTan}\left[\frac{0\ 0869456}{\sqrt{(0\ 740741 + 0\ 0333667\ fg)^2}}\right]\right)\right) -$$

$$0.00392386\ fg^2 \left(18.2482 \left(\text{Log}\left[\frac{(2 - 0\ 0333667\ fg)^2}{0\ 000749822 + (2 - 0\ 0333667\ fg)^2}\right] + \right.\right.$$

$$\text{Log}\left[\frac{(3\ 959999999999999 - 0\ 0333667\ fg)^2}{0.000187456 + (3\ 959999999999999 - 0\ 0333667\ fg)^2}\right] +$$

$$\text{Log}\left[\frac{(\frac{61}{10} - 0\ 0333667\ fg)^2}{0.000187456 + (\frac{61}{10} - 0\ 0333667\ fg)^2}\right] + \text{Log}\left[\frac{(2 + 0\ 0333667\ fg)^2}{0\ 000749822 + (2 + 0\ 0333667\ fg)^2}\right] +$$

$$\text{Log}\left[\frac{(3\ 959999999999999 + 0\ 0333667\ fg)^2}{0.000187456 + (3\ 959999999999999 + 0\ 0333667\ fg)^2}\right] +$$

$$\left.\left.\text{Log}\left[\frac{(\frac{61}{10} + 0\ 0333667\ fg)^2}{0.000187456 + (\frac{61}{10} + 0\ 0333667\ fg)^2}\right]\right) +$$

$$27.7778\ \text{Log}\left[\frac{0\ 00111334\ fg^2}{0\ 000323595 + 0\ 00111334\ fg^2}\right]\Big)$$

Fig. 4

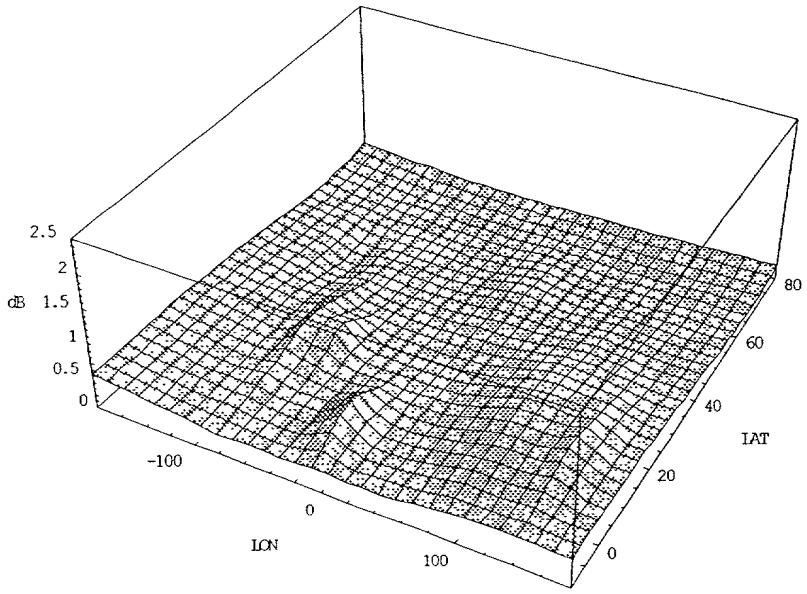

Fig. 5

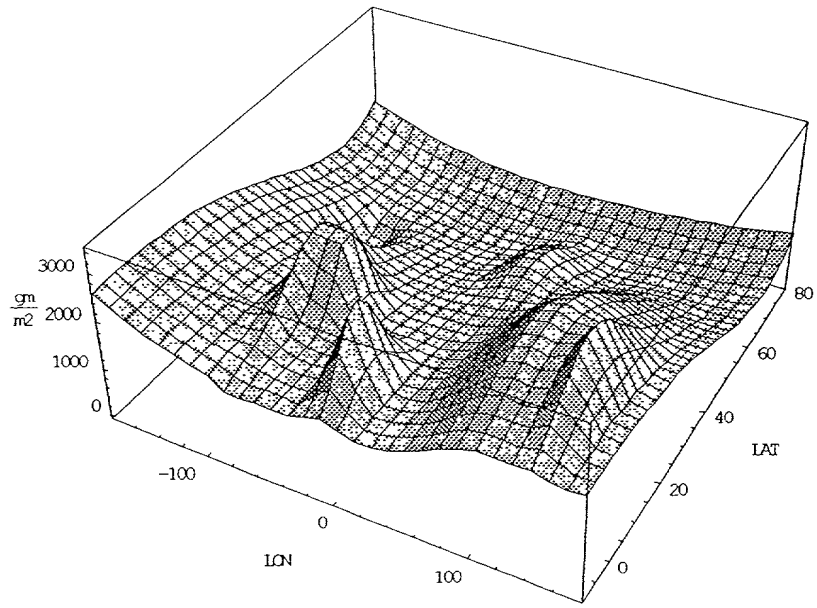

Fig. 6

-1158.02

$$\Big(1.\Big(-0.139753\Big(1.79394 \times 10^{-7}\,LAT^4 + 8.75845 \times 10^{-7}\,LAT^3 + 3.25314 \times 10^{-7}\,LONLAT^2 - 0.00176137LAT^2 + 3.07508 \times 10^{-9}\,LON^2\,LAT - 6.69472 \times 10^{-6}\,LONLAT + 0.000919687$$

$$LAT + 1.49573_e{}^{-\frac{1}{200}(10\,LAT)^2\,\frac{1}{200}(LON\,145)^2} + 2.04653_e{}^{-\frac{1}{800}(LAT\,18)^2\,\frac{(LON\,102)^2}{1800}} + 1.16178_e{}^{-\frac{1}{200}(LAT-52)^2\,\frac{1}{800}(LON-28)^2} - 2.51927_e{}^{-\frac{LAT^2}{1800}\,\frac{LON^2}{180000}} +$$

$$2.46395_e{}^{-\frac{1}{72}(LAT\,2)^2\,\frac{1}{200}(LON-7)^2} + 1.41489_e{}^{-\frac{1}{50}(LAT-20)^2\,\frac{1}{200}(LON-60)^2} - 2.25769_e{}^{-\frac{1}{200}(LAT\,28)^2\,\frac{1}{200}(LON-77)^2} + 1.69814_e{}^{-\frac{1}{200}(LAT-20)^2\,\frac{1}{128}(LON-82)^2} +$$

$$1.07578\,e^{-\frac{1}{98}(LAT-45)^2\,\frac{1}{128}(LON-110)^2} - 4.24764 \times 10^{-11}LON^4 - 3.34843 \times 10^{-8}LON^3 + 0.0000241438LON^2 - 0.000725197LON + 3.84195\Big) +$$

$$\frac{1}{(293. - 0.25\,(LAT - 40))^2}\,\Big(85849.\Big(0.139753\Big(1.79394x10^{-7}\,LAT^4 + 8.75845 \times 10^{-7}\,LAT^3 + 3\,25314 \times 10^{-7}\,LONLAT^2 - 0.00176137LAT^2 +$$

$$3\,07508 \times 10^{-9}\,LON^2\,LAT - 6.69472 \times 10^{-6}\,LONLAT + 0\,000919687\,LAT + 1.49573_e{}^{-\frac{1}{200}(10\,LAT)^2\,\frac{1}{200}(LON-145)^2} +$$

$$2.04653_e{}^{-\frac{1}{800}(LAT-18)^2\,\frac{(LON\,102)^2}{1800}} + 1\,16178_e{}^{-\frac{1}{200}(LAT-52)^2\,\frac{1}{800}(LON-28)^2} - 2.51927_e{}^{-\frac{LAT^2}{1800}\,\frac{LON^2}{180000}} + 2.46395_e{}^{-\frac{1}{72}(LAT-2)^2\,\frac{1}{200}(LON-7)^2} +$$

$$1.41489_e{}^{-\frac{1}{50}(LAT\,20)^2\,\frac{1}{200}(LON-60)^2} - 2.25769_e{}^{-\frac{1}{200}(LAT\,28)^2\,\frac{1}{200}(LON\,77)^2} + 1.69814_e{}^{-\frac{1}{200}(LAT-20)^2\,\frac{1}{128}(LON\,82)^2} +$$

$$1.07578\,e^{-\frac{1}{98}(LAT-45)^2\,\frac{1}{128}(LON\,110)^2} - 4.24764 \times 10^{-11}LON^4 - 3.34843 \times 10^{-8}LON^3 + 0.0000241438LON^2 - 0.000725197LON + 3.84195\Big) +$$

$$1.01966)\Big)$$

$$\Big(0.186801\Big(1\,79394x10^{-7}\,LAT^4 + 8\,75845 \times 10^{-7}\,LAT^3 + 3\,25314 \times 10^{-7}\,LONLAT^2 - 0.00176137LAT^2 + 3.07508 \times 10^{-9}\,LON^2\,LAT -$$

$$- 6.69472 \times 10^{-6}\,LONLAT + 0.000919687\,LAT + 1.49573_e{}^{-\frac{1}{200}(10\text{-}LAT)^2\,\frac{1}{200}(LON\,145)^2} + 2.04653_e{}^{-\frac{1}{800}(LAT\,18)^2\,\frac{(LON-102)^2}{1800}} +$$

$$1.16178_e{}^{-\frac{1}{200}(LAT-52)^2\,\frac{1}{800}(LON\,28)^2} - 2\,51927_e{}^{-\frac{LAT^2}{1800}\,\frac{LON^2}{180000}} + 2.46395_e{}^{-\frac{1}{72}(LAT\,2)^2\,\frac{1}{200}(LON-7)^2}\;1.41489_e{}^{-\frac{1}{50}(LAT-20)^2\,\frac{1}{200}(LON-60)^2} -$$

$$2.25769_e{}^{-\frac{1}{200}(LAT\,28)^2\,\frac{1}{200}(LON\,77)^2} + 1.69814_e{}^{-\frac{1}{200}(LAT-20)^2\,\frac{1}{128}(LON\,82)^2} + 1.07578\,e^{-\frac{1}{98}(LAT-45)^2\,\frac{1}{128}(LON-110)^2} -$$

$$4.24764 \times 10^{-11}LON^4 - 3.34843 \times 10^{-8}LON^3 + 0.0000241438LON^2 - 0.000725197LON + 3.84195\Big) + 0.332309\Big)\log(PR) - 0.919661\Big) -$$

$$0.764706\Big(-0.352549\Big(1.03045x10^{-7}\,LAT^4 + 2.23192 \times 10^{-7}\,LAT^3 + 2.44557 \times 10^{-7}\,LONLAT^2 - 0.000975417LAT^2 + 1.0003 \times 10^{-8}\,LON^2\,LAT - 2.18586 \times 10^{-6}\,LONLAT +$$

$$0.00128521LAT + 0.66746_e{}^{-\frac{1}{200}(10\,LAT)^2\,\frac{1}{200}(LON\,145)^2} + 1.12036_e{}^{-\frac{1}{800}(LAT-18)^2\,\frac{(LON-102)^2}{1800}} + 0.70296_e{}^{-\frac{1}{200}(LAT-52)^2\,\frac{1}{800}(LON-28)^2} - 1.28258_e{}^{-\frac{LAT^2}{1800}\,\frac{LON^2}{180000}} +$$

$$1.22726_e{}^{-\frac{1}{72}(LAT\,2)^2\,\frac{1}{200}(LON-7)^2} - 1.92779_e{}^{-\frac{1}{200}(LAT\,28)^2\,\frac{1}{200}(LON\,77)^2} + 0.865964_e{}^{-\frac{1}{200}(LAT-20)^2\,\frac{1}{128}(LON-82)^2} -$$

$$0.0909198\,e^{-\frac{1}{98}(LAT-45)^2\,\frac{1}{128}(LON-110)^2} - 1.36816 \times 10^{-10}LON^4 - 1.38211 \times 10^{-8}LON^3 + 0.000011497LON^2 - 0.000416968LON + 2.53967\Big) +$$

$$\Big(0.140592\Big(1.03045x10^{-7}\,LAT^4 + 2.23192 \times 10^{-7}\,LAT^3 + 2.44557 \times 10^{-7}\,LONLAT^2 - 0\,000975417LAT^2 + 1.0003 \times 10^{-8}\,LON^2\,LAT -$$

$$2.18586 \times 10^{-6}\,LONLAT + 0\,00128521LAT + 0.66746_e{}^{-\frac{1}{200}(10\,LAT)^2\,\frac{1}{200}(LON-145)^2} + 1\,12036_e{}^{-\frac{1}{800}(LAT-18)^2\,\frac{(LON\,102)^2}{1800}} + 0.70296_e{}^{-\frac{1}{200}(LAT\,52)^2\,\frac{1}{800}(LON-}$$

$$- 1.28258_e{}^{-\frac{LAT^2}{1800}\,\frac{LON^2}{180000}} + 1.22726_e{}^{-\frac{1}{72}(LAT-2)^2\,\frac{1}{200}(LON\,7)^2} - 1.92779_e{}^{-\frac{1}{200}(LAT\,28)^2\,\frac{1}{200}(LON-77)^2} + 0.865964_e{}^{-\frac{1}{200}(LAT-20)^2\,\frac{1}{128}(LON-82)^2} -$$

$$0.0909198\,e^{-\frac{1}{98}(LAT-45)^2\,\frac{1}{128}(LON\,110)^2} - 1.36816 \times 10^{-10}LON^4 - 1.38211 \times 10^{-8}LON^3 + 0.000011497LON^2 - 0.000416968LON + 2.53967\Big) +$$

$$0.132924\Big)\log(PR) - 0.0878644\Big)\Big)$$

Fig. 7

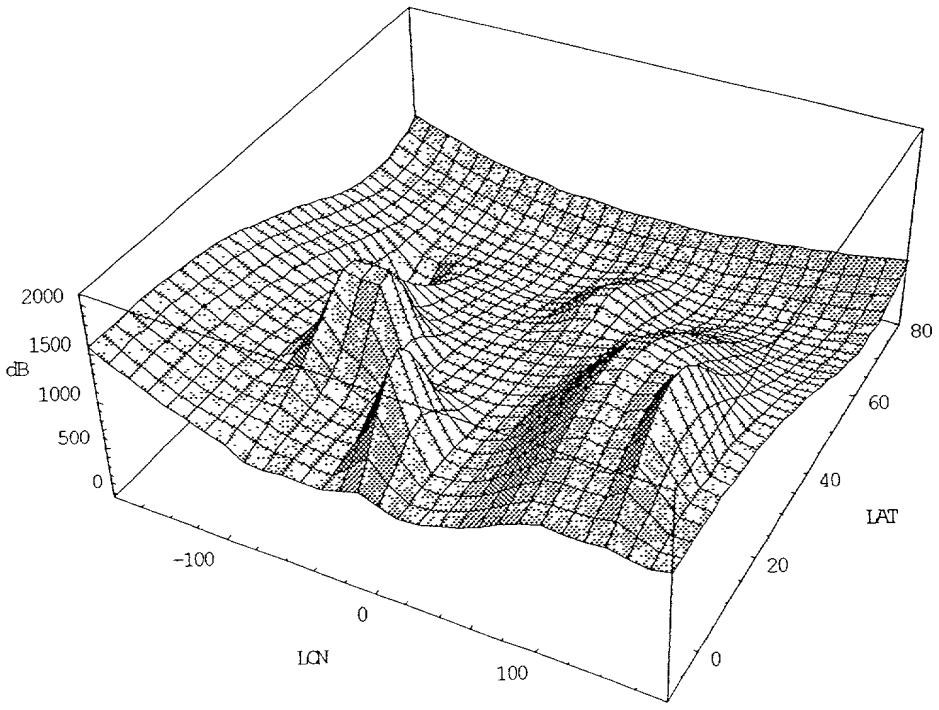

Fig. 8

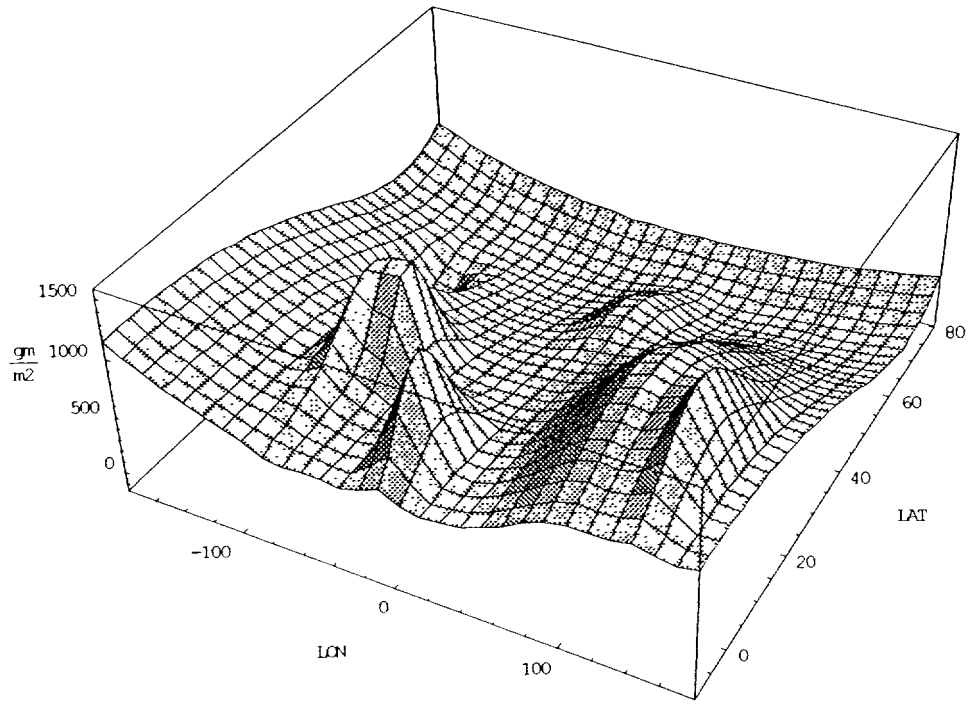

Fig. 9

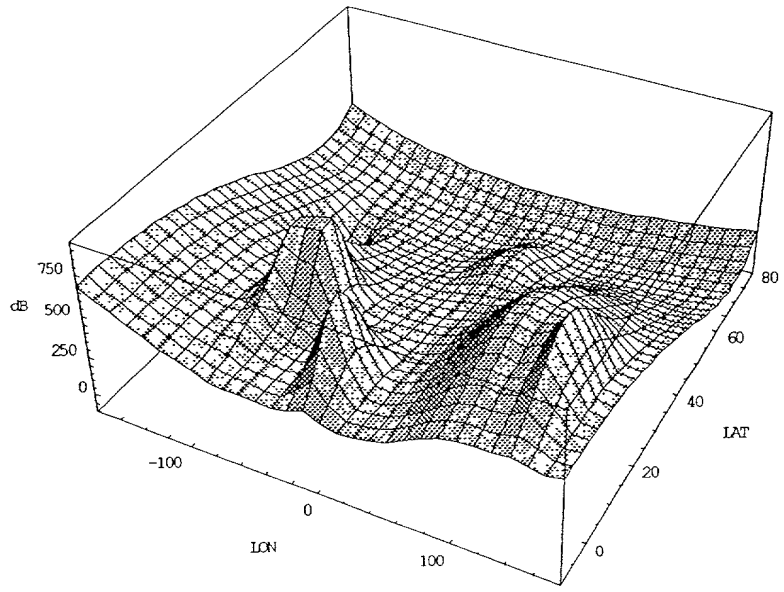

Fig. 10

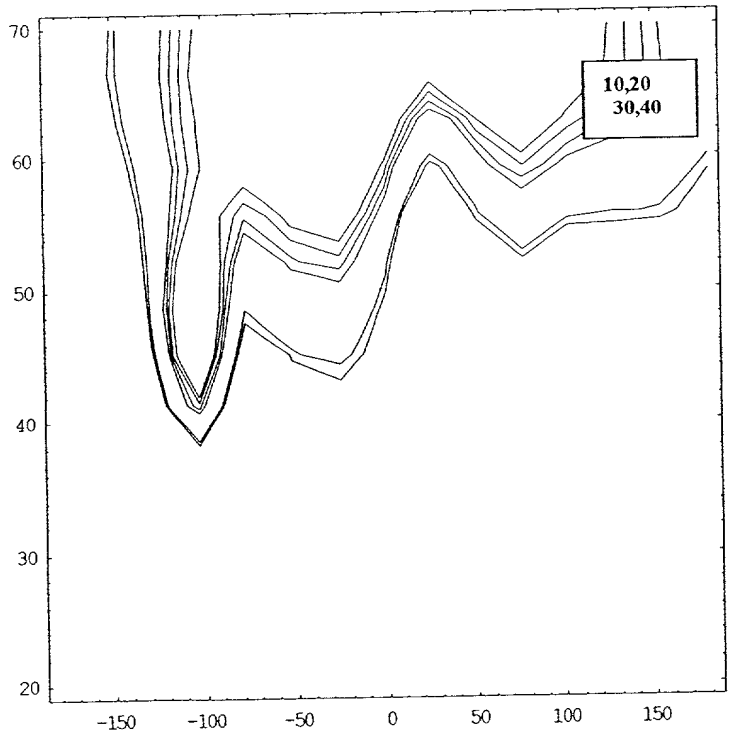

Fig. 11

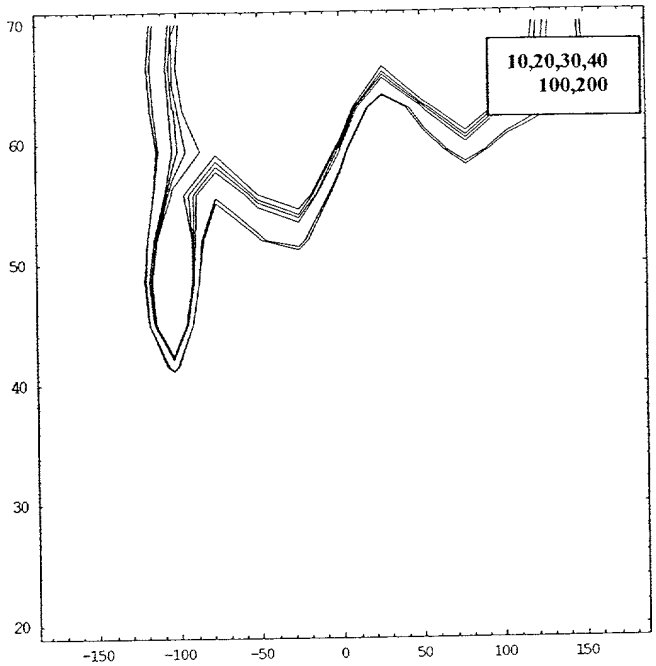
10,20,30,40
100,200
70
60
50
40
30
20
-150
-100
-50
0
50
100
150

Fig. 12

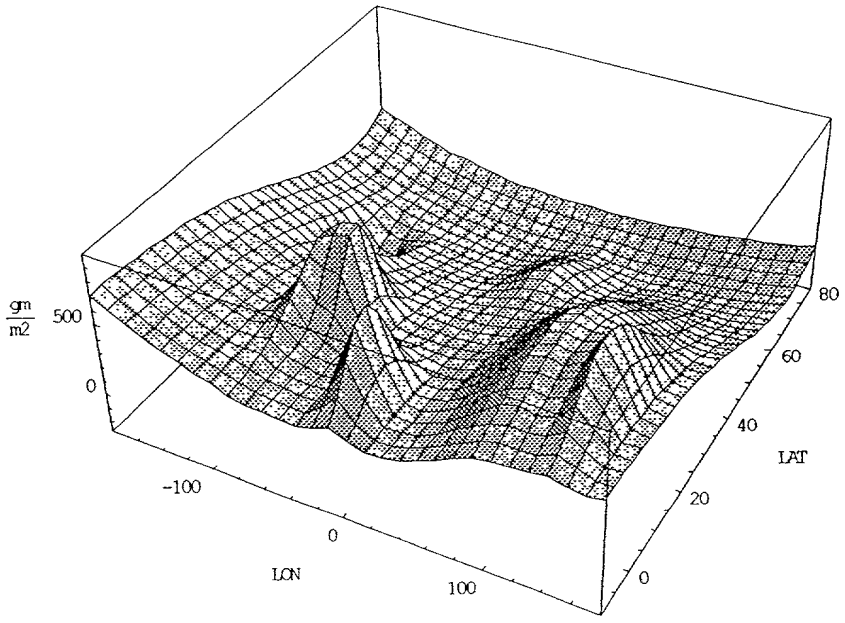
gm
m2
500
0
-100
0
LON
100
0
20
40
60
80
LAT

Fig. 13

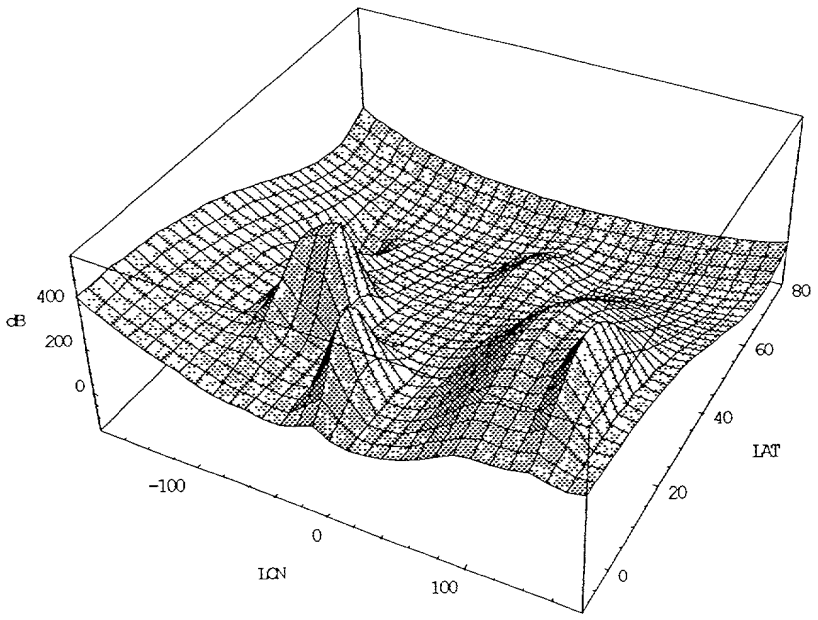
dB
400
200
0
-100
0
LON
100
0
20
40
60
80
LAT

Fig. 14

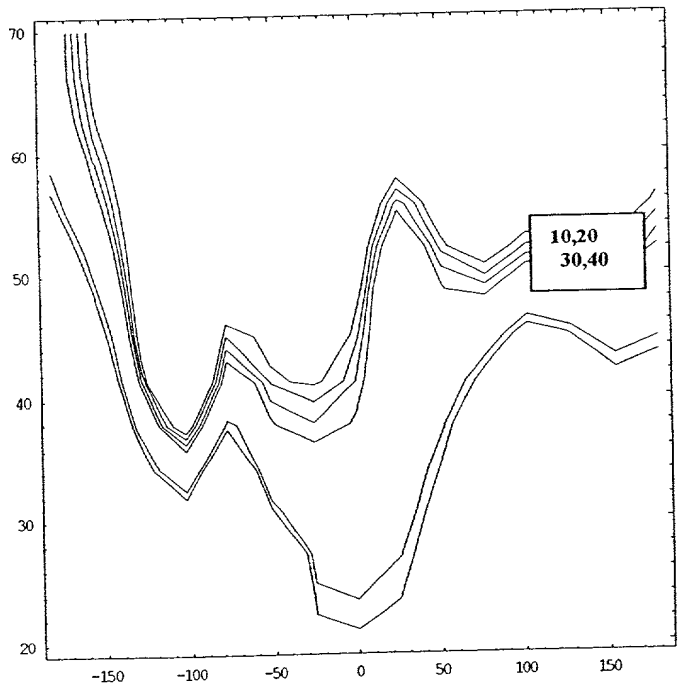
70
60
50
40
30
20
-150
-100
-50
0
50
100
150
10,20
30,40

Fig. 15

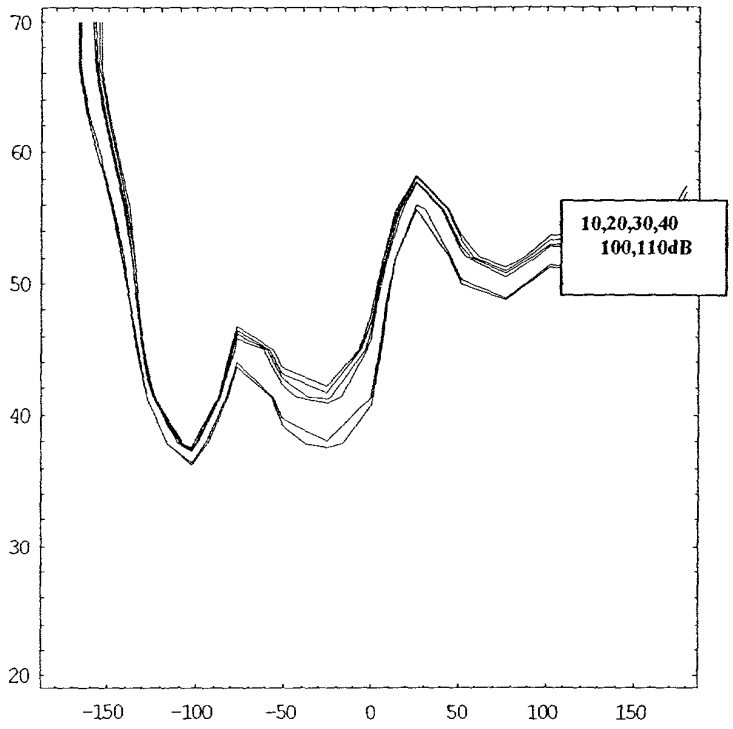

Fig. 16

Fig. 17

Fig. 18

MolniyaGEO pdf=

$$\frac{e^{-\frac{\left(5.22822\times10^{-6}\,LAT^{4}-0.000520006\,LAT^{3}+0.00512491\,LAT^{2}+0.165865\,LAT+x-47.0509\right)^{2}}{2\left(0.00002923\,8LAT^{4}-0.00526509\,LAT^{3}+0.270942\,LAT^{2}-0.776901\,LAT+181.722\,e^{-\frac{LAT^{2}}{900}}-160.041\right)^{2}}}}{\left(0.000029238\,LAT^{4}-0.00526509\,LAT^{3}+0.270942\,LAT^{2}-0.776901\,LAT+181.722\,e^{-\frac{LAT^{2}}{900}}-160.041\right)\sqrt{2\pi}}$$

With x representing elevation angle in degrees

Fig. 19

Fig. 20

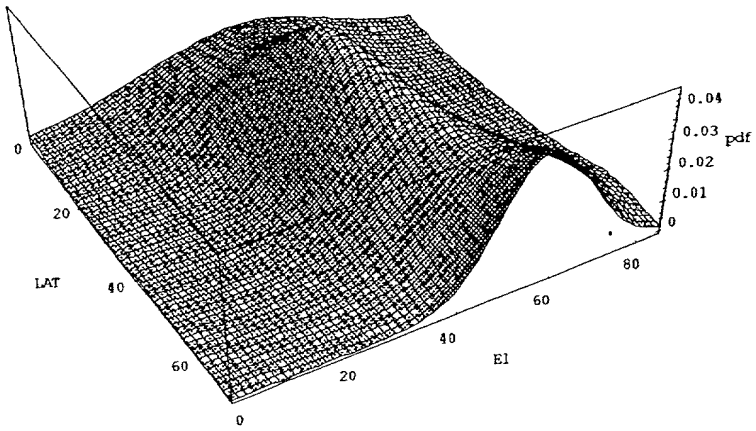

Fig. 21

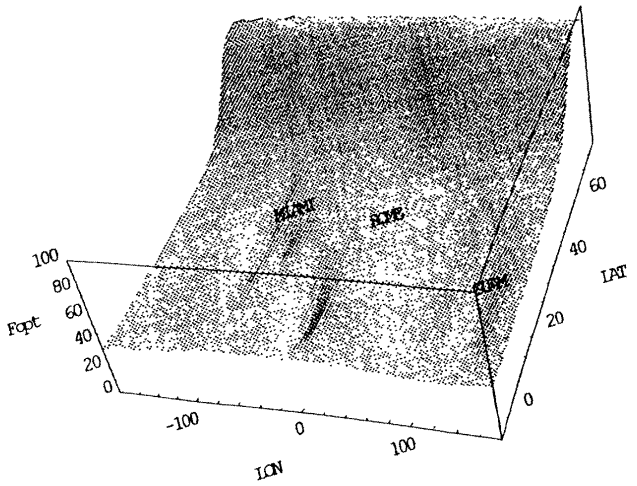

Fig. 22

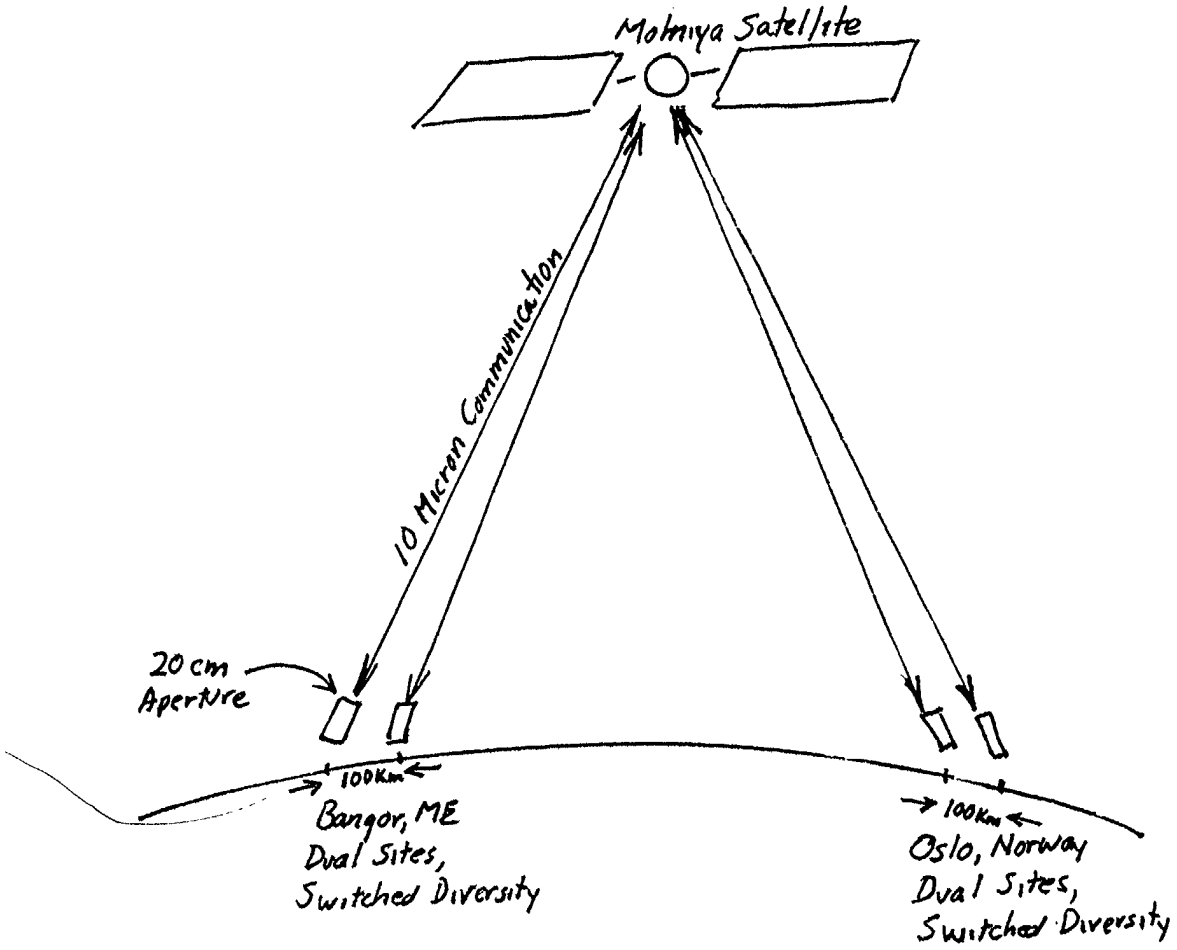

Fig. 23

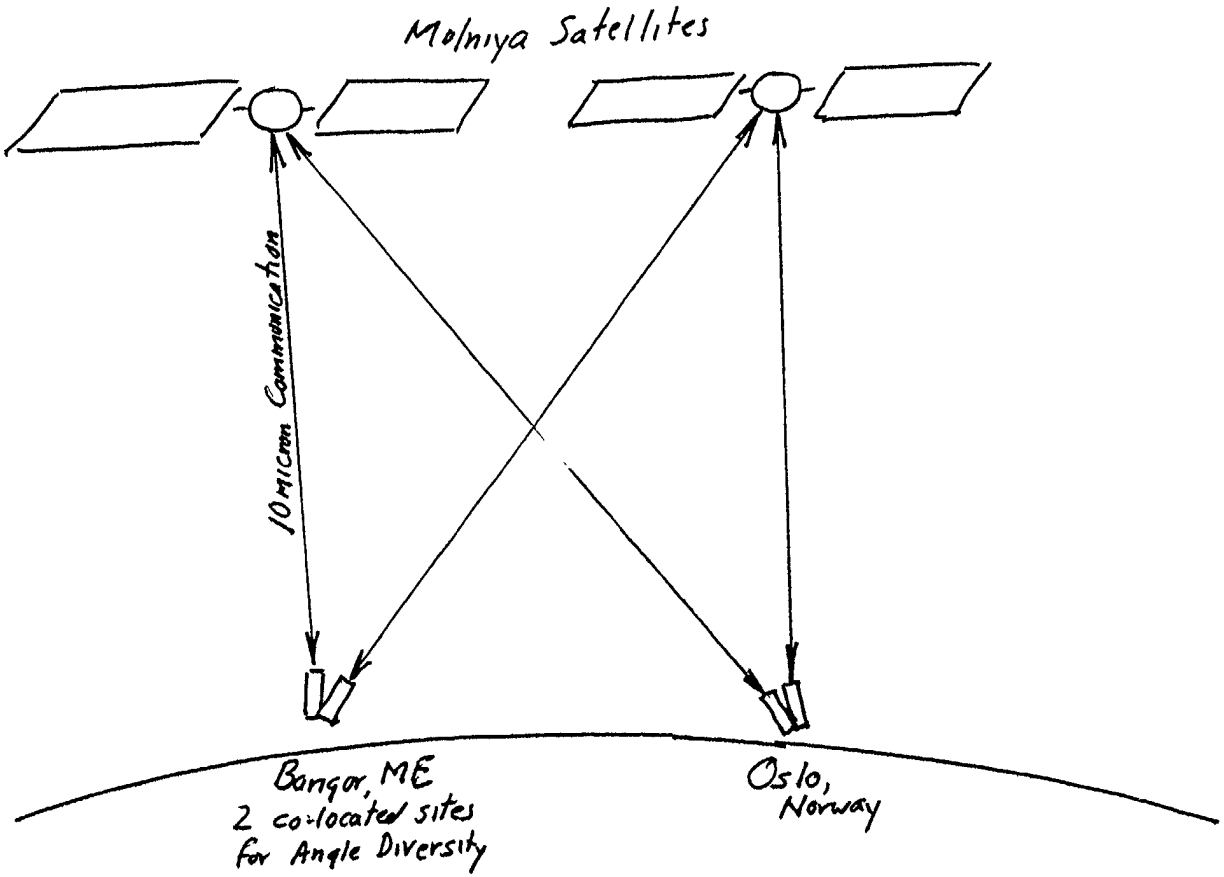
Molniya Satellites
10 MICRON COMMUNICATION
Bangor, ME
2 co-located sites
for Angle Diversity
Oslo,
Norway

Fig. 24